

# LOCATING UNIT, VEHICLE BODY ASSEMBLY MACHINE USING THE SAME AND METHOD THEREFOR

## BACKGROUND OF THE INVENTION

5 The present invention relates to vehicle body assembly machines for use in vehicle body assembly lines of automobiles and, more particularly, a general-purpose vehicle body assembly machine and a method thereof specifically suited for positioning and supporting a plurality of panels which form a vehicle body.

10 In the related art, it has heretofore been a usual practice to utilize a general-purposes vehicle body assembly machine including locating units for positioning a work a preset position in accordance with a vehicle body assembling operation as disclosed in, for example, Japanese Patent No. 2745841.

5 With such a structure, a transfer truck is mounted with a plurality of locators each of which has an operating freedom in orthogonal three axes in X-, Y- and Z-directions. As shown in FIG. 1, each of the locators includes locating unit 101, which has a locating pin 102 and a clamp arm 103, with the plural locating units being used for positioning and clamping a given panel at the preset position for a subsequent transfer to a next work stage.

10 As shown in FIG. 1, further, the locating pin 102 of each locating unit 101 is associated with a seating detection means 105, such as a proximity switch, which is mounted in an outside area adjacent to the locating pin 102 via a bracket 106 for detecting whether the locating pin 102 is precisely inserted through a locating bore 104 of the panel W11 and whether the panel W11 is seated on the locating pin 102. Thus, the seating detection means 105 functions to detect the presence of seating or unseating state of the panel W11.

25 Also, the panel W11 is formed with an embossed portion 108, which is seated on a work seating surface 107 of the locating pin 102, in a concentric relationship with the locating bore 104. With such a configuration, if the embossed portion 108 is correctly seated on the work seating surface 107, the panel is clamped with the clamp arm 103 internally located in the locating pin 102.

## SUMMARY OF THE INVENTION

With such a structure in the related art described above, the locator body has an operating freedom in the orthogonal three axes which enable a three-dimensional position of the locating pin 102 to be altered to permit the positioning operation of the panel of another car model. However, since mounting position of the seating detecting means 105 to be mounted adjacent the locating pin 102 is settled at a location depending on the shape of the panel, it is needed for the vehicle body assembly machine to be converted whenever panels of another car model are intended to be assembled, with an adverse affect on a general-purpose property of the assembly machine.

More particularly, in a case where the panel, to be positioned and supported with the locating pin 102, is altered to a panel W12 with a shape shown by a phantom line in FIG. 1, the presence of the seating detection means 105 and the bracket 106 remaining at a remarkably protruded area at the outside of the locating pin 102 causes the seating detection means 105, still remaining at its original location, to interfere with the panel W12. This results in need for the mount position of the seating detection means 105 to be converted whenever the panel W12 with an altered shape is manipulated, with a resultant excessive man-hour necessary for converting an equipment.

Further, when implementing a welding on the panel at an area closer to the aforementioned seating detection means 105 using a spot welding gun gripped by a welding robot, or when setting a traveling locus of the spot welding gun along a path in a close proximity to the seating detection means 105, similarly, there is a fear in that the spot welding gun and the seating detection means 105 mutually interfere with one another. For this reason, it is required for the mounting structure of the seating detection means 105 to be converted whenever the panel of the different shape is manipulated. Alternatively, it is undesirably required for the traveling locus of the spot welding gun, i.e. a teaching data to be modified, causing an impractical result.

On the other hand, a recent trend is to obtain a vehicle body assembly machine having a further simplified structure with a reduced spacing in view of a general-purpose property.

The present invention has been made with the above view in mind and

has an object of the present invention to provide a locating unit and a vehicle body assembly machine equipped with the locating unit, with the locating pin and a seating detection mechanism associated therewith having a capability of complying with a large number of kinds of works to allow the whole structure of the locating unit to truly have a general-purpose property.

It is another object of the present invention to provide a method for positioning and supporting a work in a fixed place with a locating unit equipped with a locating pin to be inserted through a locating bore formed in the work to allow a vehicle body assembly machine to have a general-purpose property.

According to a first aspect of the present invention, there is provided a locating unit equipped with a locating pin to be inserted through a locating bore formed in a work for positioning and supporting the work in a fixed place, said locating unit comprising: a locating pin having a root portion formed with a work seating surface; and a work seating detection mechanism mounted at said root portion and detecting the presence of seating of said work on said work seating surface.

With such a structure, the presence of the work seating detection mechanism mounted at the work seating surface of the root portion of the locating pin allows an occupying space to be minimized to provide a capability wherein when the locating pins and the locating bores of the works are normalized to be common to one another irrespective of the different kinds of the works, the work seating detection mechanism can be commonly used for a plurality of works of a large number of different kinds without converting the shapes or mounting structures of the work seating detection mechanism per se and the locating pin.

The work seating detection mechanism may be of any types such as a contact type, a non-contact type, a photoelectric type or an air pressure type, provided that a detector portion is exposed to the work seating surface of the root portion of the locating pin to detect the seating or unseating state of the work relative to the work seating surface in a turned-on or turned-off state.

According to a second aspect of the present invention, there is provided a vehicle body assembly machine for implementing a relative positioning operation among a plurality of panel-shaped works, which form a part of a

vehicle body of an automobile, prior to welding and joining the plurality of the works, said vehicle body assembly machine comprising: a plurality of locators independently mounted for respective works and each including a locating unit mainly constructed of a locating pin for positioning and supporting each of said works, said locating unit having a capability of self-isolating movement to provide a function of arbitrarily altering at least a two-dimensional position of said locating unit; wherein said locators individually perform said self-isolating movements between work set positions, wherein said works are set with respect to said respective locators, and a relative-positioning final location, wherein a mutual relative-positioning operation of said works are finally implemented, to individually move said locating units in forward or retracted directions to perform said mutual relative-positioning operation among said works; and each of said locating units includes a locating pin adapted to be inserted through a locating bore formed in each of said work for positioning and supporting said each work, said locating pin having a root portion formed with a work seating surface, and a work seating detection mechanism mounted at said work seating surface for detecting the presence of seating of said each work on said work seating surface.

According to a third aspect of the present invention, there is provided a locating unit equipped with a locating pin to be inserted through a locating bore formed in a work for positioning and supporting the work in a fixed place, said locating unit comprising: locating means having a root portion formed with a work seating surface; and detection means mounted at said work seating surface for detecting the presence of seating of said work on said work seating surface.

According to a fourth aspect of the present invention, there is provided a vehicle body assembly machine for implementing a relative positioning operation among a plurality of panel-shaped works, which form a part of a vehicle body of an automobile, prior to welding and joining the plurality of the work, said vehicle body assembly machine comprising: means for positioning and supporting each of said works and including a plurality of locating units each having a capability of self-isolating movement to provide a function of arbitrarily altering at least a two-dimensional position of said

locating unit; wherein said positioning and supporting means perform said self-isolating movements between work set positions, wherein said works are set with respect to said respective locating units, and a relative-positioning final location, wherein a mutual relative- positioning of said works are finally implemented, to individually move said locating unit in forward or retracted directions to perform said mutual relative-positioning operation among said works; and each of said locating units includes a locating pin adapted to be inserted through a locating bore formed in each of said work for positioning and supporting said each work, said locating pin having a root portion formed with a work seating surface, and a work seating detection mechanism mounted at said work seating surface for detecting the presence of seating of said each work on said work seating surface.

According to a fifth aspect of the present invention, there is provided a method for positioning and supporting a work in a fixed place with a locating unit equipped with a locating pin to be inserted through a locating bore formed in the work, said method comprising: preparing a locating pin having a root portion formed with a work seating surface, a work seating detecting mechanism mounted at said work seating surface and a clamp arm operable within said locating pin; positioning and supporting said work on said work seating surface; detecting the presence of seating of said work on said work seating surface with said work seating detection mechanism at said root portion; and clamping said work on said work seating surface with said clamp arm.

According to a sixth aspect of the present invention, there is provided a method for implementing a relative positioning operation among a plurality of panel-shaped works, which form a part of a vehicle body of an automobile, prior to welding and joining the plurality of the works, said method comprising: preparing a plurality of locators independently mounted for respective works and each including a locating unit having a capability of self-isolating movement to provide a function of arbitrarily altering at least a two-dimensional position of said locating unit, said locating unit including a locating pin adapted to be inserted through a locating bore formed in each of said work for positioning and supporting said each work, said locating pin having a root portion formed with a work seating surface, and a work seating

detection mechanism mounted at said work seating surface; operating said locators individually to perform said self-isolating movements between work set positions, wherein said works are set with respect to said respective locators, and a relative-positioning final location, wherein a mutual relative-positioning operation of said works are finally implemented to individually move said locating units in forward or retracted directions while performing said mutual relative-positioning operation among said works; detecting the presence of seating of said works on said work seating surface with said work seating detection mechanism; and clamping said works in said relative-positioning final location.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings, in which:

FIG. 1 is a schematic structural view illustrating a locating unit of the related art;

FIG. 2 is a plan view illustrating a schematic structure of a vehicle body assembly machine of a preferred embodiment according to the present invention;

FIG. 3 is a plan view of a locator jig which forms a mother body of the vehicle body assembly machine shown in FIG. 2;

FIG. 4 is a front view of the locator jig shown in FIG. 3;

FIG. 5 is a right side view of the locator jig shown in FIG. 3;

FIG. 6 is a view illustrating a detailed structure of a locator, for positioning a side panel, shown in FIG. 3;

FIG. 7 is a front view of the structure shown in FIG. 6;

FIG. 8 is a left side view of the structure shown in FIG. 7;

FIG. 9 is an enlarged view of a locating unit to be used in respective locators shown in FIGS. 3 to 5;

FIG. 10 is an enlarged partial cross sectional view of the locating unit shown in FIG. 9;

FIG. 11 is a left side view of the locating unit shown in FIG. 10;

FIG. 12 is an enlarged view of a clamp arm shown in FIG. 10; and

FIGS. 13A to 13C are schematic views illustrating a sequence of assembling panels in the vehicle body assembly machine shown in FIG. 2.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 2 is schematic plan view of a vehicle body assembly machine, including a locating unit of a preferred embodiment according to the present invention, and shows an example for performing relative positioning among four components parts, involving a dash lower panel (hereinafter referred to simply as a lower panel or panel) W1 which serves as a work, a substantially C-shaped dash upper cross member (hereinafter referred to simply as a cross member or a panel) W2 which also serves as a work and a pair of right and left cowl top side panels (hereinafter referred to simply as side panels or panels, respectively) W3, W4 all of which form a mother body of a dash panel D of an automobile, to obtain a ready state available for welding and joining prior to welding and joining steps of these component parts with respect to one another by spot welding.

Under a condition wherein the dash panel D is assembled as a part into a vehicle body, further, the cross member W2 is located on the lower panel W1 which separates a passenger compartment and an engine compartment from one another, with the side panels W3, W4 being located at both sides of the lower panel W1 and the cross member W2.

The vehicle body assembly machine shown in FIG. 2 is generally comprised of jig base 1 serving as a center of a locator jig J, a first work table 2 in which the lower panels W1 are aligned and stacked, a second work table 3 in which the cross members W2 and the side panels W3, W4 are aligned and stacked, a handling robot of a floor mount type, and a plurality of welding robots 5 (provided only one piece of welding robots being shown in FIG. 2) of tray styles mounted at an upper area of the jig base 1.

With such an arrangement, the lower panel W1 stacked on the first work pedestal is gripped by the handling robot 4 and is placed and positioned at a relative-positioning final location P1 on the jig base 1. Upon a completed positioning step of the lower panel 1, an operator M transfers a set of the cross member W2 and the pair of right and left side panels W3, W4 on the second work table 3 to work set positions P2, P3 on the jig base 1 for carrying

out a primary positioning step. Then, when the operator presses a given start switch, a self-isolating movement of the locator jig J allows the lower panel 1 and the cross member W2 and the pair of right and left side panels W3, W4 to be subjected to a mutual relative-positioning operation at the relative-positioning final location P1 to permit the welding robot 5 to perform the spot welding process. Also, depending on car models, it is possible for the cross member W2 or the side panels W3, W4 to be positioned with respect to the jig base 1 with the handling robot 4 commonly used for the lower panel W1.

FIG. 3 shows a detailed structure of the locator jig J, FIG. 4 is a front view of the locator jig J shown in FIG. 3, and FIG. 5 shows right side view of the structure shown in FIG. 3. The locator jig J includes the jig base 1 which is mounted with left and right locator pairs 6A, 6B and 7A, 7B for positioning the lower panel, a pair of locators 8A, 8B for positioning the cross member, locator pairs 9A, 9B and 10A, 10B for positioning side panels W3, W4. Each of these locators 6A, 6B~10A, 10B is constructed of an X-axis unit, a Y-axis unit and a Z-axis unit of a ball screw type driven by a NC motor, with the Z-axis unit being located at an uppermost area, which form a locator mother unit playing a role as a manipulator with an operating freedom in orthogonal three axes. In the locator mother unit, a distal end of the Z-axis unit is mounted with a locating unit 27 mainly composed of a locating pin 26. Thus, the locator is comprised of the locator mother unit and the locating unit 27. The locators 6A, 6B~10A, 10B are independently operable from one another to enable a self-isolating movement whereby each has a function to arbitrary alter a three-dimensional position of a distal end of each locating unit 27. Further, in the locators 6A, 6B and 7A, 7B for positioning the lower panel, the locating pin 26 of each locating unit 27 is directed upward. On the contrary, in the locators 8A, 8B and 10A, 10B for positioning the cross member and the side panels, the locating pin 26 of each locating unit 27 is transversely directed.

Among the plural locators 6A, 6B~10A, 10B, a typical example of a detailed structure of the locator 9A for positioning the side panel is described below in detail with reference to FIGS. 6 to 8. In FIGS. 6 to 8, the X-axis unit 15 is constructed of an X-axis motor 11, an X-axis base 13 which contains a



ball screw 12 driven with the X-axis motor 11, and an X-axis slider 14 mounted on the X-axis base 13 for sliding movement with the ball screw 12. Likewise, the Y-axis unit 20 includes a Y-axis motor 16, a Y-axis base 18 slidably mounted on the X-axis slider 14 which contains a ball screw 17 driven with the Y-axis motor 16, and a Y-axis slider 19 mounted on the Y-axis base 18. Similarly, the Z-axis unit 25 includes a Z-axis motor 22, a Z-axis base 23 connected to the Y-axis slider 19 by means of a flange 21 and containing a ball screw driven with the Z-axis motor 22, and a Z-axis slider 24 mounted on the Z-axis base 23. In addition, an upper distal end of the Z-axis slider 24 is mounted with a transversely extending locating unit 27 mainly composed of the locating pin 26 having a clamping function as will be described below in detail. As will be apparent from the foregoing description, the locator 9A is enabled to alter the three-dimensional position of the locating pin 26 in associated relationship with the X-axis unit 15, the Y-axis unit 20 and the Z-axis unit 25. Also, the other locators basically have the same structures as that of the locator 9A with the locating unit 27 for positioning the side panel.

With the structure mentioned above, when performing the relative-positioning operation of the works using the plural locators, the plural locators are moved in the forward or retracted positions in a synchronized fashion with respect to one another, the vehicle body assembly machine has a more remarkably improved positioning stability in the relative-positioning mode.

As best seen in FIGS. 3 and 5, clamping units 28 are mounted on the jig base 1 at positions adjacent the locator pair 6A, 6B and the locator pair 7A, 7B, respectively, for positioning the lower panel. Each of the clamping units 28 includes a post 29 which stands upright from the jig base 1, and a swing type clammer 31 fixedly mounted to an upper distal end of the post 29 and having an air cylinder 30 for driving the clammer 31. The lower panel W1, which forms the mother body of the dash panel D, is positioned and supported with the locators 6A, 6B and 7A, 7B and is also simultaneously clamped with the pair of clammers 28, 28.

FIGS. 9 to 11 show a detailed structure of the locating unit 27 to be mounted to the distal end of each of the locators 6A, 6B~10A, 10B. The

locating unit 27 includes a hollow post section 33 having its lower end formed with a mounting flange 32, a clamp cylinder 34 composed of an air cylinder or a hydraulic cylinder formed in a substantially rectangular pole shape and connected to the hollow post section 33 in a concentric relationship, and a tapered locating pin 26 fixedly secured to an upper distal end of the hollow post section 33 via a spacer 36 by means of a plurality of fixture bolts 37 and having a root portion formed with a seating flange section 35 with a work seating surface 35a.

As best seen in FIG. 10, the locating pin 26 is axially formed with an elongated slit 38 which penetrates through the locating pin 26 in a radial direction and which communicates with an internal space of the post section 33 to allow a clamp arm 39, formed in a substantially key configuration shown in FIG. 12, to be inserted through the elongated slit 38 and the internal space of the hollow post section 33 as a clamping unit. An upper distal end of the clamp arm 39 protrudes outward from an opening portion 40 formed at the base portion of the locating pin 26, and the other lower end of the clamp arm 39 is coupled to a piston rod 41 of the clamp cylinder 34. In addition, a substantially L-shaped recessed cam 42 is held in engagement with a fixed pin 43 radially and transversely extending from the post section 33. With such an arrangement, when protruding and retracting the piston rod 41 of the clamp cylinder 34, the clamp arm 39 is caused to operate in a clamping and unclamping operation between the clamping position C1 and an unclamping position C2. Especially during the clamping operation, the distal end of the clamp arm 39 and the seating flange 35 are brought into a clamped condition shown in FIG. 10 to clamp a given panel such as the side panel W3 in a fixed place. With such an arrangement, the locating pin 26 collectively incorporates the original positioning and supporting function and the work seating detective function as well as the work clamping function in the mother body, resulting in a further miniaturized structure with a reduced spacing.

On the other hand, the panel W3, which is positioned with the locating pin 26, is formed with a locating bore R and an embossed portion E around an circumferential periphery of the locating bore R to allow the locating pin 26 and the locating bore R to be mutually mated with one another and to concurrently allow the embossed portion E to be seated on the seating flange

35 to effectuate the final positioning of the locating pin 26.

Inside the post section 33 of the locating unit 27, a shaft 44 with stepped diameter portions is located in parallel with a central axis of the locating pin 26 for sliding movement and is urged leftward as shown in FIG. 11 by means of a compression coil spring 45. A small diameter upper end of the shaft 44 is coupled to a coupling plate 46, which laterally extends inward to have an area, offset from the shaft 44, to which a lower distal end of a detection pin 47 is connected and extends in parallel to the shaft 44 to allow an upper end of the detection pin 47 to protrude or retract from the seating flange 35 of the locating pin. Further, in the absence of the panel W3 on the seating flange 35 with the detection pin 47 protruded upward from the seating flange 35, seating the given panel W3 on the seating flange 35 allows the detection pin 47 to retract in the seating flange 35 for thereby wholly retracting the shaft 44.

Further, a work-seating detection mechanism 49 includes a proximity switch 48 which is mounted to the flange 32 of the hollow post section 33 at a location opposed to a bottom end of a large diameter portion of the shaft 44. With such a structure shown in FIG. 10, when the detection pin 47 remains protruded from the seating flange 35 with the bottom end of the large diameter portion of the shaft 44 remaining separated from the proximity switch 48, the proximity switch 48 is turned off. In contrast, the presence of the panel W3 on the seating flange 35 allows the detection pin 47 and the shaft 44 to be displaced in sliding movement such that the proximity switch 48 is turned on. With the provision of the work seating detection mechanism adapted to mechanically detect the presence of the seated condition of the work responsive to the protruding or retracting movements of the detection pin followed by the seating or unseating steps of the work on the work seating surface, it is possible for the locating pin to detect the presence of or absence of the work on the work seating surface in a more precise manner, resulting in a highly improved reliability in detection of the work on the work seating surface.

Thus, the shaft 44, the detection pin 47 and the proximity switch 48 constitute the work-seating detection mechanism which serves as a work-seating detection means for detecting seating or unseating states of the panel W3 with respect to the seating flange 35. Therefore, the sliding

displacement of the detection pin 47 and the shaft 44 owing to the seating phase of the panel W3 with respect to the seating flange 35 enables the proximity switch 48 to be turned on or turned off for detection.

5 In accordance with the vehicle body assembly machine thus constructed, consequently, when supplying the lower panel W1, which is the mother body of the dash panel D as shown in FIG. 2, to the jig base 1 using the handling robot 4, the locating pin 26 of the locating unit 27 is positioned and retained in such a position as to allow the locators 6A, 6B to position the lower panel W1 to the final relative position completed area P1. On the other hand, the  
10 locators 8A, 8B for positioning the cross member and the locators 9A, 9B and 10A, 10B for positioning the side panels position and retain the respective locating pin 26 of the relevant locating units at the work set positions P2, P3, respectively.

That is, the locators 8A, 8B for positioning the cross member support and retain the locating pins 26, 26, of the relevant locating units 27, 27, at respective positions retreated from the relative-positioning final location P1 by a given amount in the Y-direction and lowered from the relative-positioning final location P1 by a given amount in the Z-direction. Also, the locators 9A, 9B and 10A, 10B for positioning the side panel support and retain the respective locating pins 26, 26, of the relevant locating units 27, 27 at respective positions retreated from the relative-positioning final location P1 by a given amount in the X-direction and lowered from the relative-positioning final location P1 by a given amount in the Z-direction.

Then, when the lower panel W1 is supplied to and set on the jig base 1 by  
25 the handling robot 4, the locating bores R, formed at given locations of the lower panel 1 as seen in FIG. 10, are brought into engagement with the relevant locating pins 26 of the respective locators 6A, 6B and 7A, 7B and, simultaneously, the embossed portions E are brought into the seated condition with respect to the relevant seating flanges 35 of the base portions of the  
30 respective locating pins 26. As such, a primary positioning operation is completed for the lower panel W1 in conjunction with the relevant locators 6A, 6B and 7A, 7B for the positioning of the lower panel. When this takes place, also, the clamp units 28, located adjacent the relevant locators 6A, 6B and 7A, 7B for the positioning of the lower panel remain in the unclamped

states.

Upon completion of the primary positioning step of the lower panel W1, which forms the mother body of the dash panel D, in a manner described above, the operator manipulates to set the cross member W2 and the pair of left and right side panels W3, W4, which form remaining components parts of the dash panel D, to the relevant locators 9A, 9B and 10A, 10B. In particular, the cross member 2 is set such that the locating bores R preliminarily formed in the cross member W2 are brought into engagement with the relevant locating pins 26 of the respective locators 8A, 8B remaining at the work set position P2 for the positioning of the cross member to allow the relevant embossed portions E around the locating bores R to be seated on the seating flanges 35 of the relevant locating pins 26 as seen in FIG. 10. Also, the pair of side panels W3, W4 are set such that the locating bores R preliminarily formed in the side panels W3, W4 are brought into engagement with the relevant locating pins 26 of the respective locators 8A, 8B remaining at the work set position P3 for the positioning of the side panels to allow the relevant embossed portions E around the locating bores R to be seated on the seating flanges 35 of the relevant locating pins 26 as seen in FIG. 10.

A typical view of a condition wherein the primary positioning operation has been completed in conjunction with the lower panel W1 and the cross member W2 and the pair of left and right side panels W3, W4, which constitute the component elements of the dash panel, in a manner as previously noted is shown in FIG. 2. As seen in FIG. 2, while the lower panel W1 remains in the relative-positioning final location P1, the other remaining cross member W2 and the side panels W3, W4 remain in the respective work set positions P2, P3. As a result, the respective panels W1 to W4 remain in the respective conditions before carrying out the relative positioning operation among the panels and remain in the respective positions separate from one another.

In a consecutive step, when the start switch (not shown) is turned on by the operator M after the setting of the aforementioned panels W1 to W4 has been completed, the clamp arm 39, which is contained in each of the respective locating pins 26 as seen in FIG. 10, is operated for clamping action, clamping the embossed portion E, formed around the locating bore R,

between the clamp arm 39 and the seating flange 35. At the same time, the pair of clamp units 28, located adjacent the relevant locators 6A, 6B and 7A, 7B for the positioning of the lower panel operates for the clamping action, thereby clamping the lower panel W1. In such a manner, the final positioning and clamping operations are completed for the panels W1 to W4 with the relevant locators 6A, 6B to 10A, 10B.

This occurs, the work seating detection mechanisms 49, mounted at the respective locating pins 26 as seen in FIG. 10, are actuated, detecting the presence of or absence of the relevant panels W1 to W4 associated with the locators 6A, 6B to 10A, 10B. If, in this instance, the presence of the seating of any panel relevant to the locating pin 26 is not detected by any possibility, a given alarm is produced to urge the operator M to confirm the presence of the panel with respect to the relevant locator.

Subsequently, upon confirmation of the presence of all the aforementioned panels W1 to W4, the locating pin 26 moves the cross member W2, which is positioned and retained with the locating pin 26 of the locating unit 27, forward into the relative-positioning final location P1 in the X-direction while raising the locating unit 27, remaining at the upper most end, by a given height in the Z-direction in a mutual synchronism with the pair of locators 8A, 8B for the positioning of the cross member. Thus, the cross member W2 is pressed onto the lower panel W1, which has been already retained at the relative-positioning final location P1 as seen in FIG. 13A, implementing the mutual positioning operation between the lower panel W1 and the cross member W2. When this takes place, the mutual positioning-completed condition between the lower panel W1 and the cross member W2 is self-retained with the relevant locators 6A, 6B, 7A, 7B and 8A, 8B which support the respective panels W1, W2 in their positioned states.

Further, since the locators 8A, 8B for the positioning of the cross member raises the cross member W1 in the Z-direction and then moves the same forward in the X-direction at once, it is possible for the work set position P2 for setting the cross member W2 at the locators for the cross member to be settled at a height lower than the relative-positioning final location P1, with a resultant reduction in load of the operator M with an improved workability. It goes without saying that the height of the work set position P2 may be settled

to an arbitrary position depending on a physical body of the operator M.

Upon completion of the mutual positioning step between the aforementioned lower panel W1 and the cross member W2, the left and right locator pairs 9A, 9B and 10A, 10B for the positioning of the side panels are actuated to raise the respective locating units 27 by the given amount in the Z-direction in the same manner as previously noted. At the same time, the side panels W3, W4, which are positioned and supported with the relevant locating units 27 and hence the locating pins 26, are moved with the associated locating pins 26 forward to the mutual positioning-completed position P1 in the Y-direction such that the side panels W3, W4 are pressed against the lower panel W1 and the cross member W2 which have been already located at the mutual positioning-completed position P1 as seen in FIG. 13B to allow the pair of left and right side panels to be mutually positioned in the Y- and Z-directions with respect to the lower panel W1 and the cross member W2 which have already remained in the mutual-positioning-completed condition.

Consecutively, when the mutual positioning operation of the side panels W3, W4 has been completed with respect to the Y- and Z-directions in the manner described above, the left and right locator pairs 9A, 9B and 10A, 10B move the side panels W3, W4, which are positioned and retained with the respective locating units 27 and, hence, the locating pins 26 forward to the relative-positioning final location P1 in the X-direction in synchronism with the left and right locator pairs 9A, 9B and 10A, 10B for the positioning of the side panels in the same manner as discussed above to allow the side panels W3, W4 to be pressed, in the X-direction, against the lower panel W1 and the cross member W2, which have already remained at the relative-positioning final location P1 as seen in FIG. 13C. Thus, the mutual positioning operation of the pair of left and right side panels is performed in the X-direction with respect to the lower panel W1 and the cross member W2 which remain in the relative-positioning final position.

With such positioning steps mentioned above, the relative-positioning operation is completed in the three-dimensional direction, i.e. X, Y and Z directions among the lower panel W1, the cross member W2 and the side panels W3, W4 which form the component elements of the dash panel,

rendering the respective panels W1 to W4 to be mutually held in intimate contact with one another at a proper joining position. Then, a welding command signal is applied to the welding robot 5, shown in FIG. 2, which remains at a stand-by condition, thereby implementing spot welding steps to join the joining parts of the adjoining panels, completing the assembly of the dash panel D, composed of the component elements, involving the aforementioned lower panel W1 and the cross member W2 and the pair of side panels W3, W4.

In the preferred embodiment of the present invention, it is, of course, possible for the three-dimensional positions of the locating units 27 (including the respective locating pins 26) remaining at the distal ends of the respective locators 6A, 6B to 10A, 10B to be arbitrarily altered. In addition, the presence of the original functions of the locating pins 26 of the respective locating units 27 as well as the clamping functions of the clamping means composed of the clamp arms 39 and the associated work seating detection mechanisms 49 contained in the respective locating pins 26 allow the detection pins 47 of the respective clamp arms 39 and the work seating detection mechanisms 49 to effectively operate in the respective regional areas of the seating flange portions 35 of the base portions of the relevant locating pins 26. Thus, there is no fear that excessive parts or portions thereof protrude outside the locating pins 26, respectively, resulting in a miniaturized and simplified structure in each of the locating units 27.

Accordingly, even in a case where an assembly work is performed for a dash panel of a car model different from the dash panel D which has been assembled or in a case where dash panels D of different car models are intended to be assembled in a so-called mixed flow production system, preliminarily normalizing the size of the locating bores R and the size of the embossed portions E among the relevant component elements of the respective dash panels of the different car models enables the locating pins 26 to be commonly used for the vehicle bodies of all car models without the need for any modification in the work-clamping functions and the work seating detecting functions, resulting in an extremely advantageous effect in a general-purpose usage in a vehicle body assembly line.

In accordance with the present invention, since the work seating detection



mechanism, which detects the work seated on the work seating surface, is mounted at the work seating surface of the root portion of the locating pin, there is no protruded part of the work seating detection mechanism in the vicinity of a circumferential periphery of the locating pin. Thus, it is possible for only a substantially regional area of the locating pin to display a capacity for the positioning function and the seating state detecting function with only the locating pin. Consequently, preliminarily normalizing the sizes of the locating pin and the locating bore correlated therewith, notwithstanding the works of the different kinds, enables not only the locating pin but also the work seating detecting function to be commonly used for the works of the plurality of kinds. This results in an extremely improved generous-purpose property of the vehicle body assembly machine without the need for converting any component parts or equipment owing to the change of the work that would be otherwise caused in the related art practice.

Another important advantage of the present invention concerns the vehicle body assembly machine mounted with the plurality of locators, each of which is mounted at its upper distal end with the locating unit which has a function of self-isolating movement to enable at least two-dimensional position of the locating unit to be arbitrarily altered. With such a function, the respective locating units are individually moveable in the forward or retracted positions with the aforementioned self-isolating movements using at least the respective operating freedoms in the two-dimensional plane for thereby implementing the relative-positioning operation among the respective works. As a result, there is no need for preparing an additional shifting unit to perform the relative-positioning operation specific for the particular work positioned with and supported by the selected locator separately from the locators, making it possible for providing simplified and miniaturized structure in equipment in a reduced spacing.

A further important advantage of the present invention concerns a capability of readily confirming the presence of or absence of the works relative to the locators using the work seating detective function whereby the vehicle body assembly machine has an improved operating reliability as well as the work detective function. Also, since the work set positions of respective locators are enabled to be arbitrarily altered if desired, the works are set to the

locators by presetting the work set positions at respective optimum positions to cope with the operator's physical body, with a resultant favorable efficiency in the workability.

5 The entire content of Japanese Application No. P2001-22854 with a filing date of January 31, 2001 is herein incorporated by reference.

10 Although the present invention has been described above by reference to certain embodiments of the invention, the invention is not limited to the embodiments described above and modifications will occur to those skilled in the art, in light of the teachings. The scope of the invention is defined with reference to the following claims.

11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65  
66  
67  
68  
69  
70  
71  
72  
73  
74  
75  
76  
77  
78  
79  
80  
81  
82  
83  
84  
85  
86  
87  
88  
89  
90  
91  
92  
93  
94  
95  
96  
97  
98  
99  
100  
101  
102  
103  
104  
105  
106  
107  
108  
109  
110  
111  
112  
113  
114  
115  
116  
117  
118  
119  
120  
121  
122  
123  
124  
125  
126  
127  
128  
129  
130  
131  
132  
133  
134  
135  
136  
137  
138  
139  
140  
141  
142  
143  
144  
145  
146  
147  
148  
149  
150  
151  
152  
153  
154  
155  
156  
157  
158  
159  
160  
161  
162  
163  
164  
165  
166  
167  
168  
169  
170  
171  
172  
173  
174  
175  
176  
177  
178  
179  
180  
181  
182  
183  
184  
185  
186  
187  
188  
189  
190  
191  
192  
193  
194  
195  
196  
197  
198  
199  
200  
201  
202  
203  
204  
205  
206  
207  
208  
209  
210  
211  
212  
213  
214  
215  
216  
217  
218  
219  
220  
221  
222  
223  
224  
225  
226  
227  
228  
229  
230  
231  
232  
233  
234  
235  
236  
237  
238  
239  
240  
241  
242  
243  
244  
245  
246  
247  
248  
249  
250  
251  
252  
253  
254  
255  
256  
257  
258  
259  
260  
261  
262  
263  
264  
265  
266  
267  
268  
269  
270  
271  
272  
273  
274  
275  
276  
277  
278  
279  
280  
281  
282  
283  
284  
285  
286  
287  
288  
289  
290  
291  
292  
293  
294  
295  
296  
297  
298  
299  
300  
301  
302  
303  
304  
305  
306  
307  
308  
309  
310  
311  
312  
313  
314  
315  
316  
317  
318  
319  
320  
321  
322  
323  
324  
325  
326  
327  
328  
329  
330  
331  
332  
333  
334  
335  
336  
337  
338  
339  
340  
341  
342  
343  
344  
345  
346  
347  
348  
349  
350  
351  
352  
353  
354  
355  
356  
357  
358  
359  
360  
361  
362  
363  
364  
365  
366  
367  
368  
369  
370  
371  
372  
373  
374  
375  
376  
377  
378  
379  
380  
381  
382  
383  
384  
385  
386  
387  
388  
389  
390  
391  
392  
393  
394  
395  
396  
397  
398  
399  
400  
401  
402  
403  
404  
405  
406  
407  
408  
409  
410  
411  
412  
413  
414  
415  
416  
417  
418  
419  
420  
421  
422  
423  
424  
425  
426  
427  
428  
429  
430  
431  
432  
433  
434  
435  
436  
437  
438  
439  
440  
441  
442  
443  
444  
445  
446  
447  
448  
449  
450  
451  
452  
453  
454  
455  
456  
457  
458  
459  
460  
461  
462  
463  
464  
465  
466  
467  
468  
469  
470  
471  
472  
473  
474  
475  
476  
477  
478  
479  
480  
481  
482  
483  
484  
485  
486  
487  
488  
489  
490  
491  
492  
493  
494  
495  
496  
497  
498  
499  
500  
501  
502  
503  
504  
505  
506  
507  
508  
509  
510  
511  
512  
513  
514  
515  
516  
517  
518  
519  
520  
521  
522  
523  
524  
525  
526  
527  
528  
529  
530  
531  
532  
533  
534  
535  
536  
537  
538  
539  
540  
541  
542  
543  
544  
545  
546  
547  
548  
549  
550  
551  
552  
553  
554  
555  
556  
557  
558  
559  
560  
561  
562  
563  
564  
565  
566  
567  
568  
569  
570  
571  
572  
573  
574  
575  
576  
577  
578  
579  
580  
581  
582  
583  
584  
585  
586  
587  
588  
589  
590  
591  
592  
593  
594  
595  
596  
597  
598  
599  
600  
601  
602  
603  
604  
605  
606  
607  
608  
609  
610  
611  
612  
613  
614  
615  
616  
617  
618  
619  
620  
621  
622  
623  
624  
625  
626  
627  
628  
629  
630  
631  
632  
633  
634  
635  
636  
637  
638  
639  
640  
641  
642  
643  
644  
645  
646  
647  
648  
649  
650  
651  
652  
653  
654  
655  
656  
657  
658  
659  
660  
661  
662  
663  
664  
665  
666  
667  
668  
669  
670  
671  
672  
673  
674  
675  
676  
677  
678  
679  
680  
681  
682  
683  
684  
685  
686  
687  
688  
689  
690  
691  
692  
693  
694  
695  
696  
697  
698  
699  
700  
701  
702  
703  
704  
705  
706  
707  
708  
709  
710  
711  
712  
713  
714  
715  
716  
717  
718  
719  
720  
721  
722  
723  
724  
725  
726  
727  
728  
729  
730  
731  
732  
733  
734  
735  
736  
737  
738  
739  
740  
741  
742  
743  
744  
745  
746  
747  
748  
749  
750  
751  
752  
753  
754  
755  
756  
757  
758  
759  
760  
761  
762  
763  
764  
765  
766  
767  
768  
769  
770  
771  
772  
773  
774  
775  
776  
777  
778  
779  
780  
781  
782  
783  
784  
785  
786  
787  
788  
789  
790  
791  
792  
793  
794  
795  
796  
797  
798  
799  
800  
801  
802  
803  
804  
805  
806  
807  
808  
809  
810  
811  
812  
813  
814  
815  
816  
817  
818  
819  
820  
821  
822  
823  
824  
825  
826  
827  
828  
829  
830  
831  
832  
833  
834  
835  
836  
837  
838  
839  
840  
841  
842  
843  
844  
845  
846  
847  
848  
849  
850  
851  
852  
853  
854  
855  
856  
857  
858  
859  
860  
861  
862  
863  
864  
865  
866  
867  
868  
869  
870  
871  
872  
873  
874  
875  
876  
877  
878  
879  
880  
881  
882  
883  
884  
885  
886  
887  
888  
889  
890  
891  
892  
893  
894  
895  
896  
897  
898  
899  
900  
901  
902  
903  
904  
905  
906  
907  
908  
909  
910  
911  
912  
913  
914  
915  
916  
917  
918  
919  
920  
921  
922  
923  
924  
925  
926  
927  
928  
929  
930  
931  
932  
933  
934  
935  
936  
937  
938  
939  
940  
941  
942  
943  
944  
945  
946  
947  
948  
949  
950  
951  
952  
953  
954  
955  
956  
957  
958  
959  
960  
961  
962  
963  
964  
965  
966  
967  
968  
969  
970  
971  
972  
973  
974  
975  
976  
977  
978  
979  
980  
981  
982  
983  
984  
985  
986  
987  
988  
989  
990  
991  
992  
993  
994  
995  
996  
997  
998  
999  
1000  
1001  
1002  
1003  
1004  
1005  
1006  
1007  
1008  
1009  
1010  
1011  
1012  
1013  
1014  
1015  
1016  
1017  
1018  
1019  
1020  
1021  
1022  
1023  
1024  
1025  
1026  
1027  
1028  
1029  
1030  
1031  
1032  
1033  
1034  
1035  
1036  
1037  
1038  
1039  
1040  
1041  
1042  
1043  
1044  
1045  
1046  
1047  
1048  
1049  
1050  
1051  
1052  
1053  
1054  
1055  
1056  
1057  
1058  
1059  
1060  
1061  
1062  
1063  
1064  
1065  
1066  
1067  
1068  
1069  
1070  
1071  
1072  
1073  
1074  
1075  
1076  
1077  
1078  
1079  
1080  
1081  
1082  
1083  
1084  
1085  
1086  
1087  
1088  
1089  
1090  
1091  
1092  
1093  
1094  
1095  
1096  
1097  
1098  
1099  
1100  
1101  
1102  
1103  
1104  
1105  
1106  
1107  
1108  
1109  
1110  
1111  
1112  
1113  
1114  
1115  
1116  
1117  
1118  
1119  
1120  
1121  
1122  
1123  
1124  
1125  
1126  
1127  
1128  
1129  
1130  
1131  
1132  
1133  
1134  
1135  
1136  
1137  
1138  
1139  
1140  
1141  
1142  
1143  
1144  
1145  
1146  
1147  
1148  
1149  
1150  
1151  
1152  
1153  
1154  
1155  
1156  
1157  
1158  
1159  
1160  
1161  
1162  
1163  
1164  
1165  
1166  
1167  
1168  
1169  
1170  
1171  
1172  
1173  
1174  
1175  
1176  
1177  
1178  
1179  
1180  
1181  
1182  
1183  
1184  
1185  
1186  
1187  
1188  
1189  
1190  
1191  
1192  
1193  
1194  
1195  
1196  
1197  
1198  
1199  
1200  
1201  
1202  
1203  
1204  
1205  
1206  
1207  
1208  
1209  
1210  
1211  
1212  
1213  
1214  
1215  
1216  
1217  
1218  
1219  
1220  
1221  
1222  
1223  
1224  
1225  
1226  
1227  
1228  
1229  
1230  
1231  
1232  
1233  
1234  
1235  
1236  
1237  
1238  
1239  
1240  
1241  
1242  
1243  
1244  
1245  
1246  
1247  
1248  
1249  
1250  
1251  
1252  
1253  
1254  
1255  
1256  
1257  
1258  
1259  
1260  
1261  
1262  
1263  
1264  
1265  
1266  
1267  
1268  
1269  
1270  
1271  
1272  
1273  
1274  
1275  
1276  
1277  
1278  
1279  
1280  
1281  
1282  
1283  
1284  
1285  
1286  
1287  
1288  
1289  
1290  
1291  
1292  
1293  
1294  
1295  
1296  
1297  
1298  
1299  
1300  
1301  
1302  
1303  
1304  
1305  
1306  
1307  
1308  
1309  
1310  
1311  
1312  
1313  
1314  
1315  
1316  
1317  
1318  
1319  
1320  
1321  
1322  
1323  
1324  
1325  
1326  
1327  
1328  
1329  
1330  
1331  
1332  
1333  
1334  
1335  
1336  
1337  
1338  
1339  
1340  
1341  
1342  
1343  
1344  
1345  
1346  
1347  
1348  
1349  
1350  
1351  
1352  
1353  
1354  
1355  
1356  
1357  
1358  
1359  
1360  
1361  
1362  
1363  
1364  
1365  
1366  
1367  
1368  
1369  
1370  
1371  
1372  
1373  
1374  
1375  
1376  
1377  
1378  
1379  
1380  
1381  
1382  
1383  
1384  
1385  
1386  
1387  
1388  
1389  
1390  
1391  
1392  
1393  
1394  
1395  
1396  
1397  
1398  
1399  
1400  
1401  
1402  
1403  
1404  
1405  
1406  
1407  
1408  
1409  
1410  
1411  
1412  
1413  
1414  
1415  
1416  
1417  
1418  
1419  
1420  
1421  
1422  
1423  
1424  
1425  
1426  
1427  
1428  
1429  
1430  
1431  
1432  
1433  
1434  
1435  
1436  
1437  
1438  
1439  
1440  
1441  
1442  
1443  
1444  
1445  
1446  
1447  
1448  
1449  
1450  
1451  
1452  
1453  
1454  
1455  
1456  
1457  
1458  
1459  
1460  
1461  
1462  
1463  
1464  
1465  
1466  
1467  
1468  
1469  
1470  
1471  
1472  
1473  
1474  
1475  
1476  
1477  
1478  
1479  
1480  
1481  
1482  
1483  
1484  
1485  
1486  
1487  
1488  
1489  
1490  
1491  
1492  
1493  
1494  
1495  
1496  
1497  
1498  
1499  
1500  
1501  
1502  
1503  
1504  
1505  
1506  
1507  
1508  
1509  
1510  
1511  
1512  
1513  
1514  
1515  
1516  
1517  
1518  
1519  
1520  
1521  
1522  
1523  
1524  
1525  
1526  
1527  
1528  
1529  
1530  
1531  
1532  
1533  
1534  
1535  
1536  
1537  
1538  
1539  
1540  
1541  
1542  
1543  
1544  
1545  
1546  
1547  
1548  
1549  
1550  
1551  
1552  
1553  
1554  
1555  
1556  
1557  
1558  
1559  
1560  
1561  
1562  
1563  
1564  
1565  
1566  
1567  
1568  
1569  
1570  
1571  
1572  
1573  
1574  
1575  
1576  
1577  
1578  
1579  
1580  
1581  
1582  
1583  
1584  
1585  
1586  
1587  
1588  
1589  
1590  
1591  
1592  
1593  
1594  
1595  
1596  
1597  
1598  
1599  
1600  
1601  
1602  
1603  
1604  
1605  
1606  
1607  
1608  
1609  
1610  
1611  
1612  
1613  
1614  
1615  
1616  
1617  
1618  
1619  
1620  
1621  
1622  
1623  
1624  
1625  
1626  
1627  
1628  
1629  
1630  
1631  
1632  
1633  
1634  
1635  
1636  
1637  
1638  
1639  
1640  
1641  
1642  
1643  
1644  
1645  
1646  
1647  
1648  
1649  
1650  
1651  
1652  
1653  
1654  
1655  
1656  
1657  
1658  
1659  
1660  
1661  
1662  
1663  
1664  
1665  
1666  
1667  
1668  
1669  
1670  
1671  
1672  
1673  
1674  
1675  
1676  
1677  
1678  
1679  
1680  
1681  
1682  
1683  
1684  
1685  
1686  
1687  
1688  
1689  
1690  
1691  
1692  
1693  
1694  
1695  
1696  
1697  
1698  
1699  
1700  
1701  
1702  
1703  
1704  
1705  
1706  
1707  
1708  
1709  
1710  
1711  
1712  
1713  
1714  
1715  
1716  
1717  
1718  
1719  
1720  
1721  
1722  
1723  
1724  
1725  
1726  
1727  
1728  
1729  
1730  
1731  
1732  
1733  
1734  
1735  
1736  
1737  
1738  
1739  
1740  
1741  
1742  
1743  
1744  
1745  
1746  
1747  
1748  
1749  
1750  
1751  
1752  
1753  
1754  
1755  
1756  
1757  
1758  
1759  
1760  
1761  
1762  
1763  
1764  
1765  
1766  
1767  
1768  
1769  
1770  
1771  
1772  
1773  
1774  
1775  
1776  
1777  
1778  
1779  
1780  
1781  
1782  
1783  
1784  
1785  
1786  
1787  
1788  
1789  
1790  
1791  
1792  
1793  
1794  
1795  
1796  
1797  
1798  
1799  
1800  
1801  
1802  
1803  
1804  
1805  
1806  
1807  
1808  
1809  
1810  
1811  
1812  
1813  
1814  
1815  
1816  
1817  
1818  
1819  
1820  
1821  
1822  
1823  
1824  
1825  
1826  
1827  
1828  
1829  
1830  
1831  
1832  
1833  
1834  
1835  
1836  
1837  
1838  
1839  
1840  
1841  
1842  
1843  
1844  
1845  
1846  
1847  
1848  
1849  
1850  
1851  
1852  
1853  
1854  
1855  
1856  
1857  
1858  
1859  
1860  
1861  
1862  
1863  
1864  
1865  
1866  
1867  
1868  
1869  
1870  
1871  
1872  
1873  
1874  
1875  
1876  
1877  
1878  
1879  
1880  
1881  
1882  
1883  
1884  
1885  
1886  
1887  
1888  
1889  
1890  
1891  
1892  
1893  
1894  
1895  
1896  
1897  
1898  
1899  
1900  
1901  
1902  
1903  
1904  
1905  
1906  
1907  
1908  
1909  
1910  
1911  
1912  
1913  
1914  
1915  
1916  
1917  
1918  
1919  
1920  
1921  
1922  
1923  
1924  
1925  
1926  
1927  
1928  
1929  
1930  
1931  
1932  
1933  
1934  
1935  
1936  
1937  
1938  
1939  
1940  
1941  
1942  
1943  
1944  
1945  
1946  
1947  
1948  
1949  
1950  
1951  
1952  
1953  
1954  
1955  
1956  
1957  
1958  
1959  
1960  
1961  
1962  
1963  
1964  
1965  
1966  
1967  
1968  
1969  
1970  
1971  
1972  
1973  
1974  
1975  
1976  
1977  
1978  
1979  
1980  
1981  
1982  
1983  
1984  
1985  
1986  
1987  
1988  
1989  
1990  
1991  
1992  
1993  
1994  
1995  
1996  
1997  
1998  
1999  
2000  
2001  
2002  
2003  
2004  
2005  
2006  
2007  
2008  
2009  
2010  
2011  
2012  
2013  
2014  
2015  
2016  
2017  
2018  
2019  
2020  
2021  
2022  
2023  
2024  
2025  
2026  
2027  
2028  
2029  
2030  
2031  
2032  
2033  
2034  
2035  
2036  
2037  
2038  
2039  
2040  
2041  
2042  
2043  
2044  
2045  
2046  
2047  
2048  
2049  
2050  
2051  
2052  
2053  
2054  
2055  
2056  
2057  
2058  
2059  
2060  
2061  
2062  
2063  
2064  
2065  
2066  
2067  
2068  
2069  
2070  
2071  
2072  
2073  
2074  
2075  
2076  
2077  
2078  
2079  
2080  
2081  
2082  
2083  
2084  
2085  
2086  
2087  
2088  
2089  
2090  
2091  
2092  
2093  
2094  
2095  
2096  
2097  
2098  
2099  
2100  
2101  
2102  
2103  
2104  
2105  
2106  
2107  
2108  
2109  
2110  
2111  
2112  
2113  
2114  
2115  
2116  
2117  
2118  
2119  
2120  
2121  
2122  
2123  
2124  
2125  
2126  
2127  
2128  
2129  
2130  
2131  
2132  
2133  
2134  
2135  
2136  
2137  
2138  
2139  
2140  
2141  
2142  
2143  
2144  
2145  
2146  
2147  
2148  
2149  
2150  
2151  
2152  
2153  
2154  
2155  
2156  
2157  
2158  
2159  
2160  
2161  
2162  
2163  
2164  
2165  
2166  
2167  
2168  
2169  
2170  
2171  
2172  
2173  
2174  
2175  
2176  
2177  
2178  
2179  
2180  
2181  
2182  
2183  
2184  
2185  
2186  
2187  
2188  
2189  
2190  
2191  
2192  
2193  
2194  
2195  
2196  
2197  
2198  
2199  
2200  
2201  
2202  
2203  
2204  
2205  
2206  
2207  
2208  
2209  
2210  
2211  
2